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(54) METHOD OF PRODUCING FLEXIBLE TEXTURED THERMOPLASTICS SHEETS

(71) We, REHAU PLASTIKS GMBH, a German Body Corporate, of 8673 Rehau, Rheniumhaus, West Germany, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

A method of producing dense flexible sheet-like structures such as tarpaulins or awnings having at least one textured surface or at least one smooth surface of synthetic thermoplastic material, in which method the synthetic material is brought to the plastic tacky state by the effect of heat and is compressed to form the sheet-like structure.

Methods of producing for example tarpaulins, awnings and containers are known in which cloths made of natural or synthetic filaments are coated with synthetic materials. The primary purpose of the coating is to render the cloth water-proof.

In the known process coating is carried out by first applying to the cloth a priming coating as it is called, to which the required adhesives may be added. This priming coating must be applied in two operations to the two faces of the cloth. The synthetic material e.g. polyvinyl chloride applied with the priming coating passes through the interstices between the filaments of the cloth and by forming tiny columnur structures thus creates good adhesion between the two layers of synthetic material. A top coating is applied to the priming coating on each face of the cloth in two further stages, and the top coating becomes intimately bonded with the priming coating as a result of the addition of an adhesive to the latter. Both the priming coating and the top coating are generally applied by means of blades having wide squeegees, scrapers, rollers etc. The coating conditions such as temperature, period of dwell etc, vary from case to case and must be adjusted to suit the particular application and the type of coating equipment available.

A particular disadvantage of the above-described process is considered to reside in the fact that when coating equipment incorporating a coating bench is used, the cloth has to be passed four times through the tunnel of the apparatus. Although it has been proposed to use two coating benches one behind the other in the manufacture of tarpaulin materials, the resultant shortened throughput time is offset by the increased complexity and cost of the equipment.

A further disadvantage of the known method that has emerged is that it permits virtually only monochrome articles to be produced. Although it is possible to provide relatively wide stripes of different colours on one web of material, additional complicated coating equipment is required which limits in advance the possibilities of providing a multi-coloured product.

In another known method a laminate is produced which may include a layer of reinforcing material. In this method for example, a sheet-like structure of synthetic material may be applied by the application of pressure and heat to one or both sides of a flat reinforcing structure consisting for instance of textile threads.

Films or the like of synthetic material can be used in this method as the sheet-like structure. Each of these films is heated on that of its faces presented to the reinforcing layer until plasticization takes place and thus the necessary tackiness is achieved for effecting a bond with the reinforcing layer. The actual bonding of the film prepared in this manner with the reinforcing layer takes place under pressure which can be applied by for example a pair of calender rolls.

The reinforcing layer can be coated on one or both sides. Coating on both sides can be carried out in a single operation.

[*Price 25p*]

However it is also possible first to apply a coating on one side and then to coat the second face in a second stage.

The known coating method may also be repeated several times so that multiple coating is achieved.

The disadvantage of this method is considered to reside in the fact that apart from the need for very complex processing equipment, it is only possible in principle to produce laminates having monochrome coatings. The reason for this is that the films of synthetic material used for coating purposes and the sheet-like structures can generally be produced only in one colour. However, it has recently become possible to provide on a limited basis wide stripes of different colours in such films and sheet-like structures and thus to some extent to provide a colour difference in such laminates.

Apart from the aforementioned disadvantages the two above-described known methods suffer from the further considerable disadvantage that to obtain the end products only synthetic materials to which a single degree of hardness has been imparted can be used. Furthermore only a single prescribed synthetic material having the same hardness and other mechanical properties throughout can be used in each coating operation. No possibility exists of applying a coating the properties of which can be varied both by varying the material and imparting differing properties (hardness) to the material, and which also has differing colours.

This invention accordingly provides a method of producing a flexible thermoplastics sheet which method comprises forming a woven, warp knitted or braided fabric from filaments of at least one synthetic thermoplastics material and subsequently consolidating the thermoplastics material of the fabric by the application of heat and pressure to render the fabric impermeable.

Preferably the filaments of thermoplastics material will comprise threads, wires or tapes coated with thermoplastics material.

All the known materials such as natural or synthetic fibres, wire etc, can be used as the embedded reinforcing substances. These embedded substances are coated by any known method with synthetic thermoplastic material, and the customary extruders can be used for the purpose.

The coating can also be achieved by a dipping process. The filaments coated with synthetic material that are so obtained are formed into sheet-like structures by weaving, braiding or warp-knitting using the appropriate machines, and the width of the structure is determined by the machine used, e.g. a loom, whereas there is no fixed limit to its length.

Filaments of differing colours and extending in the longitudinal and/or transverse directions can be used in the production of this sheet-like structure, these filaments being produced by coating the embedded reinforcing substances with synthetic materials of differing colours, one of the above-mentioned coating processes being used for the purpose. In this way a wide variety of patterns to suit particular uses can be produced. Additional patterning effects can be produced by varying the weave of the threads to give for example twill, herring-bone, sculptured and fancy weaves.

Furthermore, because of the possibility of using filaments having synthetic coatings each of varying hardness, dense sheet-like structures the flexibility of which varies within the structure, can be produced.

In this connection combinations are feasible in which for example the weave includes, in the warp direction of the sheet-like structure, a filament coated with a relatively hard synthetic material, whereas in the weft direction it has filaments of another material for example, to which threads hardness of a reduced degree has been imparted. The strength, stability and flexibility provided by a combination of this kind differs from those of a sheet-like structure made of filaments coated with one and the same synthetic material. Differing mechanical properties can also be achieved if for instance filaments coated with foam material are combined with filaments having coatings in a harder or softer synthetic material. Variation of the mechanical properties within a sheet-like structure of this kind can also be achieved by varying the closeness of the weave of the coated filaments in one or both directions and from zone to zone. In this way bending zones can be formed in the structure, and these provide increased flexibility without adversely affecting the ability of the structure to exclude air and water.

Furthermore, while producing the sheet-like structure made in accordance with the method of the invention it is possible to introduce, in one and/or both directions of the weave of coated filaments, a metal wire or filament which can form an additional element for reinforcing the sheet-like structure. Instead of such metal wire or filament, strips of synthetic or other reinforcing materials can be introduced into the weave. Thus, in combination with the bendable zones formed by varying the closeness of the weave of the coated filaments, it is possible to impart properties to the sheet-like structure whereby it retains its shape.

It is also possible, when using wire inserts, to employ these for example for supplying power for heating purposes. In this way a further field of application is opened for the

sheet-like structures produced in accordance with the invention.

According to the invention, sheet-like structures produced in this manner are heated until the coating of synthetic material on the reinforcing embedded material passes into the thermoplastic state. The heat required for this purpose can be provided by any known heating device. It is for example feasible to provide the heat through heated calander rollers. In this manner the pressure required for effecting consolidation can be applied directly when converting the coating of synthetic material to the thermoplastic state. It is however also feasible to apply the heat to the material to be consolidated, for example by means of infra-red radiant heaters or heating tunnels and then to apply the pressure necessary for consolidation to the sheet-like structure. In this case the pressure-producing apparatus must be fitted immediately beyond the heating equipment since pressure has to be applied to the sheet-like structure while the synthetic material is still on the thermoplastic state.

Upon application of heat the coating of the thermoplastic material on the embedded reinforcing material is brought to the thermoplastic state. The coating of synthetic material softened in this way is compacted by the application of pressure to the faces of the structure, and the juxtaposed portions of the coating of synthetic material are consolidated from both sides. This consolidating treatment results in a completely dense skin of synthetic material in the middle of which are embedded the reinforcing elements.

By using the method of the invention the sheet-like structure can be provided on both faces with a smooth surface, and in contrast to the known method, an appearance resembling that of a textile material is retained.

It is also possible for one face of the material to be smooth whereas the woven structure is fully retained on the other face. The effect of the woven structure can also be provided on both faces.

It has been found advantageous to carry out consolidation at temperatures that are at least as high as the crystalline melting point of the synthetic material used as the coating. In the case of purely amorphous thermoplastic materials, e.g. polyvinyl chloride, the temperature and pressure must be so selected that the requirements for good consolidation are met. The temperature range in the case of polyvinyl chloride is from 120° to 220°C for example, and the rate of travel of the material through the heating apparatus is directly related to the degree of softening of the synthetic material. The application of pressure can be variable and depends upon the thickness of the sheet-like structure to be treated and upon the degree of plasticization of the synthetic material.

The consolidated sheet-like structure is preferably cooled directly after consolidation in order to avoid disintegration of the plasticized synthetic material.

It has also proved advantageous for all or some of the woven filaments used as the starting material for the consolidation operation carried out in producing the sheet-like structure to be coated with a foam plastics material. It is also advantageous to replace the textile filaments by metal wire or metal filaments inserts as the reinforcing means. These metallic reinforcing means can be used directly for heating or conducting purposes for example. It is however also feasible to introduce metal filaments into a sheet-like structure produced by the method of the invention, at the same time as the filamentary structure, coated with synthetic material, is being woven, which metal filaments can then be used for example for heating or conducting purposes.

These metal inserts can also constitute additional reinforcement means for the sheet-like structure.

The steps used in the method will now be described:

A reinforcing element e.g. a filament consisting of a synthetic endless thread is coated with a synthetic material in an extrusion process. These coated filaments are woven on a loom to form a flat web of cloth. At the next stage the web of cloth is heated by an exterior source until the coating of synthetic material is converted into the plastic state. At this moment exterior pressure is applied to squeeze the faces of the plasticized synthetic material and to consolidate it by compression with adjacent portions of the coating, thus forming an air-tight and water-proof sheet.

The squeezing of the faces of the coating of synthetic material is continued until the reinforcing element is completely embedded in the synthetic material. After this consolidating step, the web of sheet material is cooled and made up for example into rolls which can be stored.

The synthetic materials that can be used for the method of the invention are all those thermoplastic substances that can be used over a wide temperature range. Some examples are mentioned below, but the materials that can be used are not limited to these.

Example 1

The reinforcing elements are coated with an ethylene-vinyl-acetate copolymer. In the case of thermoplastic materials of this kind plasticization begins at a temperature as low as approximately 80°C. Consolidation can be carried out at this temperature by

the application of a suitable amount of pressure. However, a higher temperature, e.g. 100°C, and a lower pressure can be advantageously used.

Example 2

If polyvinyl chloride is used as the coating material, consolidation can begin at a temperature of 120°C, but the operation can be carried out more rapidly at temperatures of 200°C and above.

Example 3

When polyethylene and in particular high-pressure polyethylene is used, consolidation generally starts at a temperature of 110°C but this temperature can be raised to 200° and above. In the case of low-pressure polyethylene consolidation begins at approximately 130°C but can be carried out at temperatures of up to more than 200°C.

Example 4

The consolidation of polypropylene begins at temperatures of approximately 160°C and can be carried out up to a maximum temperature of approximately 250°C.

Example 5

An upper extreme case is that of polyamide, the initiation of consolidation of which takes place at temperatures around 200°C depending upon the type of polyamide employed. When this synthetic material is used, the consolidation temperature can be raised to 350°C.

The pressure necessary for effecting consolidation can be applied by means of plate presses, calander rolls and similar pressure-producing equipment.

The applications of the sheet-like structures produced in accordance with the invention are virtually unlimited.

They can be used wherever cloths coated with synthetic materials have been employed in the past, e.g. for producing tarpaulins for, for example, lorries and railway trucks; roof coverings, inflatable edifices, tarpaulins for use on ships; tent tops, awnings, flexible containers, load-supporting cloths for use in conveyor systems; protective clothing etc. Futhermore, because of the possibility of providing multi-coloured material and as a result of the additional patterning effects in the weave, the webs of cloth produced by the method of the invention can be used in the manufacture of a considerable number of articles employed for leisure-time purposes and in sporting activities. Also, because of the possibility of providing a multi-coloured product and one that is textured, wide fields of application in which the aesthetic aspect is important are opened by the use of sheet-like structures of the kind dealt with above.

WHAT WE CLAIM IS:—

1. A method of producing a flexible thermoplastics sheet which method comprises forming a woven, warp knitted or braided fabric from filaments of at least one synthetic thermoplastics material and subsequently consolidating the thermoplastics material of the fabric by the application of heat and pressure to render the fabric impermeable.

2. A method as claimed in claim 1 wherein both faces of the sheet are provided with a smooth surface.

3. A method as claimed in claim 1 wherein one face of the sheet is provided with a smooth surface and the other face retains a woven structure.

4. A method as claimed in claim 1 wherein both faces of the sheet retain a woven structure.

5. A method as claimed in any one of claims 1 to 4 wherein the filaments of synthetic thermoplastics material comprise means for reinforcing the filaments coated with the synthetic thermoplastics material.

6. A method as claimed in claim 5 wherein the means for reinforcing the filaments comprises metal wire.

7. A method as claimed in claim 5 wherein the means for reinforcing the filaments comprises fibrous threads of natural fibres.

8. A method as claimed in claim 5 wherein the means for reinforcing the filaments comprises filaments of synthetic fibres.

9. A method as claimed in any one of claims 5 to 8 wherein the means for reinforcing the filament are coated with a plastics foam material.

10. A method as claimed in any one of claims 1 to 9 wherein more than one type of synthetic thermoplastic material having varying degrees of hardness are used.

11. A method as claimed in any one of claims 1 to 10 wherein there are present monochromatic thermoplastics filaments of differing colours.

12. A method as claimed in any one of claims 1 to 11 wherein the fabric is formed by weaving or by warp knitting.

13. A method as claimed in any one of claims 1 to 12 wherein the thermoplastics material comprises polyvinylchloride, polyethylene ethylene-vinylacetate copolymer, polypropylene or a polyamide.

14. A method as claimed in any one of claims 1 to 13 and substantially as hereinbefore described in any one of the Examples.

15. A sheet whenever produced by the method claimed in any one of claims 1 to 14.

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